ME451: Control Systems Laboratory

Lab Coordinator: Professor Clark Radcliffe
2445 EB, Ph: (517) 355-5198, email: radcliffe@egr.msu.edu
Laboratory Location: 1532EB
Website: http://www.egr.msu.edu/classes/me451/radcliff/lab

Objectives:

- Learn to simulate dynamic systems in the Matlab environment,
- Familiarize the student with theoretical and practical aspects of making physical measurements,
- Introduce the student to a variety of transducers and instrumentation used by mechanical engineers,
- Familiarize students with the behavior of control systems and enable them to understand the role the system parameters in control system response,
- Develop skills in writing technical reports.

Experiments:

1 1^{st} Order Time Response Model: DC Servo Motor

2 2^{nd} Order Time Response Model: Mass-Spring-Damper System

3 Frequency Response Model: Operational Amplifier Circuit

4 1^{st} Order Frequency Response Model: DC Servo Motor

5 2^{nd} Order Frequency Response Model: Torsional Mass-Spring-Damper System

6 Air Temperature Control with Process Delay

Laboratory Grading:

Short Forms (9) 60%

Matlab Workshop, (6) Experiments, (2) Design Projects

Formal Reports (2) 40%

To pass the ME451 course, you must pass the ME451 laboratory component.

Laboratory Schedule:

Each section will be divided into three groups: Groups A, B, and C. The group assignments will be posted outside room 1532EB before the second week of the semester. All groups of a particular section will attend the laboratory at their scheduled time, and perform experiments as per the schedule shown:

Laboratory Reports:

Wk	Date	Group A	Group B	Group C
1	9/2	No Lab	No Lab	No Lab
2	9/7 Mon: Labor Day	Writing Workshop (any Tu-Th Lab)	Writing Workshop (any Tu-Th Lab)	Writing Workshop (any Tu-Th Lab)
3	9/14	Math & Matlab	Math & Matlab	Math & Matlab
4	9/21	1st Order Time Response Modeling	No Lab	2nd Order Time Response Modeling
5	9/28	2nd Order Time Response Modeling	1st Order Time Response Modeling	No Lab
6	10/5	No Lab	2nd Order Time Response Modeling	1st Order Time Response Modeling
7	10/12	Op Amp Frequency Response Modeling	No Lab	1st Order Frequency Response Modeling
8	10/19	1st Order Frequency Response Modeling	Op Amp Frequency Response Modeling	No Lab
9	10/26	No Lab	1st Order Frequency Response Modeling	Op Amp Frequency Response Modeling
10	11/2	2nd Order Frequency Response Modeling	No Lab	Air Temperature Control Response
11	11/9	Air Temperature Control Response	2nd Order Frequency Response Modeling	No Lab
12	11/16	No Lab	Air Temperature Control Response	2nd Order Frequency Response Modeling
13	11/23 Thanksgiving	No Lab	No Lab	No Lab
14	11/30	**Design Project 1**	**Design Project 1**	**Design Project 1**
15	12/7	**Design Project 2**	**Design Project 2**	**Design Project 2**
16	12/15	Finals Week	Finals Week	Finals Week

Short Forms: After performing each experiment, students should complete and turn in their respective short forms to the laboratory TA. These forms will be graded and returned in the next class. The short forms are included in the laboratory handout at the end of each experiment description.

Formal Reports: Each student will have to write two formal reports during the semester. Students writing their report will turn in their rough draft one week after completing the lab (For example, a week 5 lab report is due at the beginning of the lab in week 6). The draft reports will be reviewed by your laboratory TA and Craig Gunn, and suggestions for improvement will be provided to the student at the following week's lab

period. The revised, final, version of the report is then due at the beginning of the lab period 3 weeks after the lab. The final version of the report will be graded.

Draft: Two copies of the report must be submitted

Final: One final report copy, two marked up drafts and electronic copy (emailed to TA)

Notes:

(1) 100% laboratory attendance is mandatory.

(2) Laboratory work accounts for 25% of the overall grade for ME451

(3) Students can reschedule their laboratory time only in special situations, through PRIOR arrangements made with TA' s. If a laboratory is missed without prior arrangement, the student will receive a zero.

(4) Short forms have to be submitted at the end of the laboratory

(5) Late formal reports will not be accepted unless PRIOR arrangements have been made with the laboratory coordinator.

(6) Laboratory handouts are available in the course web pages

(7) Read the laboratory handout for each week's lab BEFORE coming to the laboratory. You may otherwise face difficulty completing your experiment.

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M E M O R A N D U M

TO: *GreenWind*™ Development Group
FROM: C. Radcliffe, Controls Group Supervisor
DATE: September 4, 2009
SUBJ: Modeling and Control Development Tests for Electric Automobile Drivetrain Design



1. The Automotive Systems Development Center is currently in the first phase of design, development, and testing of an electric automobile power system - the *GreenWind*™. The goal of this project is to provide a new standard in automotive electric power system performance and efficiency for the 21st century. This new electric power system should provide 30% better energy efficiency over currently available products in the marketplace. The new design should provide a 150,000 hour median life before failure and provide a significant improvement in its dynamic response to load changes. The electric power drivetrain system will incorporate whatever state-of-the-art materials and techniques are required to achieve the above goals.

2. During the next few 10 weeks, all members of the *GreenWind*™ Development Group will participate in the testing and evaluation of instrumented prototype systems. This instrumentation is planned for use during development testing to be conducted in the second phase of the project. It is important to understand the characteristics of the instrumentation and its operation as well as the control technologies involved so that we will be able to conduct laboratory tests of the new product quickly and accurately using the best techniques available. For each of six weeks, the Controls Group has assembled an exercise in one of the technical areas required for our development program. Our technical staff will help you investigate these topics.

TOPICS

1st Order Time Response Model: DC Servo Motor
2nd Order Time Response Model: Mass-Spring-Damper System
Frequency Response Model: Operational Amplifier Circuit
1st Order Frequency Response Model: DC Servo Motor
2nd Order Frequency Response Model: Torsional Mass-Spring-Damper System
Air Temperature Control with Process Delay

3. You will prepare a short report on each of the above areas and a formal technical report on one of the above areas. The staff will provide a sheet outlining the issues to be addressed in each short report. Information on the format of the Formal Technical Report is available from the group website.

Plagiarism Policy

Department of Mechanical Engineering
Michigan State University

Plagiarism is not tolerated in the Department of Mechanical Engineering. It shall be punished according to the student conduct code of the University. Integrity and honesty are essential to maintain society's trust in the engineering profession. This policy is intended to reinforce these values.

For the purpose of this policy, plagiarism means presenting, as one's own, without proper citation, the words, work or opinions of someone else.

A. You commit plagiarism if you submit as your own work:

1. Part or all of an assignment copied from another person's assignment, including reports, drawings, web sites, computer files, or hardware.

2. Part or all of an assignment copied or paraphrased from a source, such as a book, magazine, pamphlet, web site, or web posting, without proper citation

3. The sequence of ideas, arrangement of material, pattern or thought of someone else, even though you express them in your own words. Plagiarism occurs when such a sequence of ideas is transferred from a source to a paper without the process of digestion, integration and reorganization in the writer's mind, and without acknowledgement in the paper.

B. You are an accomplice in plagiarism and equally guilty if you:

1. Knowingly allow your work, in preliminary or finished form, to be copied and submitted as the work of another.

2. Prepare an assignment for another student, and allow it to be submitted as his or her own work.

3. Keep or contribute to a file of assignments with the clear intent that these assignments will be copied and submitted as the work of anyone other than the originator of the assignment. (The student who knows that his or her work is being copied is presumed to consent to its being copied.)

(based upon the MSU English Department's policy on plagiarism)